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CENTRE DE RECHERCHE SUR LES TRANSPORTS

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ABSTRACT

This paper presents an impact analysis of a subway extension in Montreal. The extension was opened in 1976; it started operating just before the Summer Olympics and included two stations giving easy access to the Olympic Stadium. The analyses are based on large-scale regional O-D surveys carried out by the MUCTC (the local transit operator) every four years since 1970. Due to the amount and nature of data as well as to the programming package MADITUC (a Model for the Disaggregate Analysis of Trips on a Transit Network), it was possible to perform some specific studies, allowing the identification of the main impacts related to the extension.

In summary, on a short term horizon, no urbanistic structuring effect was observed following the subway extension : general trends of population decrease and aging were continuing in the surrounding sectors. This extension however had a positive influence on transit ridership. Transit users experienced significant gains in travel time and a decrease in their number of transfers. Nevertheless, the effect on modal split was limited in space and time, thus being very local. This attraction phenomenon seems to be significant only within a distance of 1.6 kilometers from the subway line. In fact after an initial increase, the market share for the public transit started decreasing, reaching sometimes lower levels than those in the pre-extension period.

RÉSUMÉ

Un peu avant les jeux olympiques d'été de 1976, Montréal inaugurait le prolongement "est" de la ligne de métro #1, dont deux stations donnaient précisément accès au complexe olympique. Le présent document fait état d'une étude d'impacts de ce nouveau tronçon. Les analyses s'appuient sur les données des enquêtes régionales Origine-Destination de la Commission de Transport de la Communauté Urbaine de Montréal (C.T.C.U.M.), qui eurent lieu en 1970, 1974, 1978 et 1982. Grâce à la nature et à la quantité des données disponibles, et à l'aide du logiciel MADITUC (Modèle d'Analyse Désagrégée des Itinéraires en Transport Urbain Collectif), il fut possible de mesurer certains impacts sur la structure démographique, sur la demande de transport, sur la répartition modale et sur les temps de déplacement des usagers.

En résumé, il ne semble pas y avoir eu, du moins à court terme, d'effets structurants importants sur le profil démographique des secteurs environnants; le vieillissement et la baisse de la population s'y sont poursuivis. Par contre, le prolongement a eu une influence positive sur la demande de transport en commun, notamment à cause de gains de temps significatifs et d'une baisse du nombre de correspondances nécessaires pour effectuer les déplacements. Malgré cela, l'impact observé sur la répartition modale semble avoir été très limité dans l'espace et dans le temps. En effet, d'une part, l'attraction ne semble s'être manifestée qu'à l'intérieur d'un rayon de 1,6 km autour des nouvelles stations. D'autre part, il semble bien que la part de marché de la C.T.C.U.M., qui a augmenté tout de suite après le prolongement, s'est par la suite remise à descendre, atteignant parfois des niveaux plus bas que ceux mesurés durant la période qui a précédé le prolongement.

INTRODUCTION

The subway system (also called metro) of the City of Montreal has been gradually extended since the inauguration in 1966 of the first three lines with 26 stations. Due to these extensions, the number of stations has more than doubled and is now 55. Table 1 allows to compare the size of the Montreal system with those of several other cities.

City	Population ($\times 10^6$)	Journeys (annual) ($\times 10^6$)	Veh - km (annual) ($\times 10^6$)	Network length (km)	Average distance between station (km)
Paris	8.5	1 156.0	190.0	192.0	0.67
Mexico	16.5	1 117.0	162.0	93.2	1.01
New-York	18.0	1 006.0	434.0	385.0	0.83
Toronto	2.1	243.0	70.0	59.6	0.93
Montréal	2.7	191.0	61.0	45.3	0.92
Chicago	6.7	147.0	82.0	162.8	1.16
Boston	2.7	143.4	—	64.3	1.26
Washington	2.8	89.0	—	103.0	1.72
Philadelphia	3.7	98.0	19.0	39.4	0.74
San Francisco	3.2	54.0	47.0	114.0	3.35
Baltimore	0.8	45.0	—	12.9	1.08
Atlanta	1.8	21.0	6.0	40.0	1.60
Cleveland	1.5	7.0	3.0	33.8	1.88
Miami	1.7	4.8	—	33.6	1.68

Table 1. Comparison of different subway systems (source: (1), (2)).

One of the most important extensions was opened to the public in 1976, the year of the Olympic Games hosted by Montreal. Line number 1 was then increased by 9 stations to the East and two of these newly built stations gave easy access to the Olympic site; two years later, line 1 was also extended in the western part by 8 stations. Because of the data and tools involved, the

present paper focuses on the measurement of impacts caused by the Eastern subway extension.

From a general standpoint, magnitude of public investments involved and the permanent nature of the infrastructure are the main concerns that justify the best attention of transportation and urban planners. Other associated issues are also of great public interest, thus generating lengthy public discussions in regard to subway alignment, stations localization and surface network reconfiguration.

To legitimize large investment projects, transportation planners, in an era of evolutive technology and information systems, are required to use more and better models to evaluate different scenarios and to forecast relevant and most probable impacts. The present study (see for more details Lavigueur et al. (1985) (3)) tries to contribute to the still limited knowledge on the impact of rapid transit lines. In fact, the a posteriori analysis offers the possibility to compare the predicted impact to the one that was really observed and would permit to confirm, reject or improve the hypotheses formulated a priori. In this sense, the a posteriori analysis becomes the motor of the evolution of the techniques, principles and hypotheses used in transportation systems planning.

The paper is organized as follows. Firstly, a description is made of the analytical methodology (data and tools) and of the main questions addressed. Secondly, this is the presentation of the general situation of public transport in Montreal, followed by the identification of the influence zone of the Eastern subway extension. Then, multiple impacts are considered according to an after/before comparison basis: demographic characteristics, modal split, travel attributes, C.B.D. accessibility and benefits evaluation.

PLANNING AND EVALUATION METHODOLOGY

The main purpose of the proposed analysis comes from a distinctive point of view. Instead of looking at all the possible impacts observed after the implementation of a subway extension --such as new residential or commercial developments, added value of adjacent lands--, the experiment consists primarily of an evaluation exercise performed strictly in the same conditions --data and tools-- as the planning exercise considered available before the project. It rather tends to validate planning techniques and to evaluate several of the more commonly made hypotheses concerning the impact of subway extensions.

The main opportunity of analysis comes from the fact that the 1976 eastern subway extension is surrounded by two large regional Origin and Destination surveys conducted in the fall seasons of 1974 and 1978 by the MUCTC's (Montreal Urban Community Transit Corporation) Service Planning Department. More interestingly, the trends perceived in 1978 can be validated with another O-D survey conducted in 1982. All these surveys were of the telephone interview type with an average sampling rate of about 5 per cent, considering the coded and validated answers of, respectively, 43000, 55000 and 75000 households.

The surveys provide - for each traveller interviewed- socio-economic characteristics (such as age, sex, car ownership etc.), the zones of origin and destination of every trip made and, if the trip has been made by public transit, the sequence of transit lines used. (For more details see MUCTC 1972 (4), 1975 (5), 1979 (6), 1983 (7)) This very detailed information on transit lines actually used allows to compare, at a very disaggregate level, route and mode choice before and after the subway extensions. This point will be stressed to some extent in a subsequent paragraph.

Data concerning the supply of public transport are those used in 1974 and 1978 for planning purposes; this level of resolu-

tion is sufficient for network simulation or capacity analysis for a peak period, but is still too crude for a precise evaluation of the operational costs involved. Nevertheless, for comparative analyses, they provide a good representation of the supply issues during the 1974 and 1978 surveys. For instance, the 1978 MUCTC transit network is coded with about 140 lines (subway, train, bus), 2000 nodes and 1400 centroids of zones, and 5000 transit links.

With the aforementioned numbers, the error margin may be considered well under 10 per cent for large volumes, such as those encountered in a subway analysis.

To deal with this large database environment, the following software tools were used: first,the transit network planning package MADITUC (a Model for the Disaggregate Analysis of Trips on a Transit Network (8))for the processing of NETWORK data, the modeling of ACCESS links, the computation of shortest PATHs according to a CALIBRATEd impedance function, and the LOADING of the observed or simulated trips on the network; second, the statistical analysis system SAS (from the SAS Institute 1982 (9), 1985 (10)) for the files manipulation --MERGEing, SORTing, NEW variable GENERATION, STATISTICAL comparative analyses-- and the production of GRAPHICAL representation of results in reference to the territorial system.

The important questions addressed in a planning context of a subway extension are of the following kind:

- What will be the area of influence of the subway line 1 extension? (in the Montreal context, planners were also interested in the reduction of the maximum load point of the perpendicular line 2)

- Does the subway line have a real structuring effect in terms of urbanistic aspects, as having some influence on demographic trends, car ownership? Are these effects dis-

cernable on a short run horizon?

- Do the changes in the transit levels of service have measurable influence on car usage? on modal split?

- What will be the impact on supply resources to be provided by the transit operator? Scale economies?

- What are the real travel benefits to the actual transit users?

Before trying to answer this non-exhaustive list of questions, a short overview of the public transport scene in the Montreal region is necessary.

PUBLIC TRANSPORT IN MONTREAL

The City of Montreal is located on an Island in the St. Lawrence river, where it forms, together with 26 other surrounding municipalities, the Montreal Urban Community (MUC); inside the MUC perimeter corresponding mainly to the Island, the MUCTC is responsible for public transportation. Outside, the northern region is served by the city of Laval Transit Authority while the southern part of the territory is served by the Montreal South Shore Transit Corporation. Figure 1 shows the Island and the subway network in 1974 and in 1978 as well as the Olympic complex and the CBD which attracts an important part of work trips due to its economic activities.

The last survey in 1982 showed a population of 1 777 000 on the Island of Montreal, in an area of 487 square km. The O-D survey covered an area seven times larger (including the suburbs outside the MUC) with a population of 2 896 000 for 147 municipalities. The City of Montreal itself had a population of about 1 000 000.

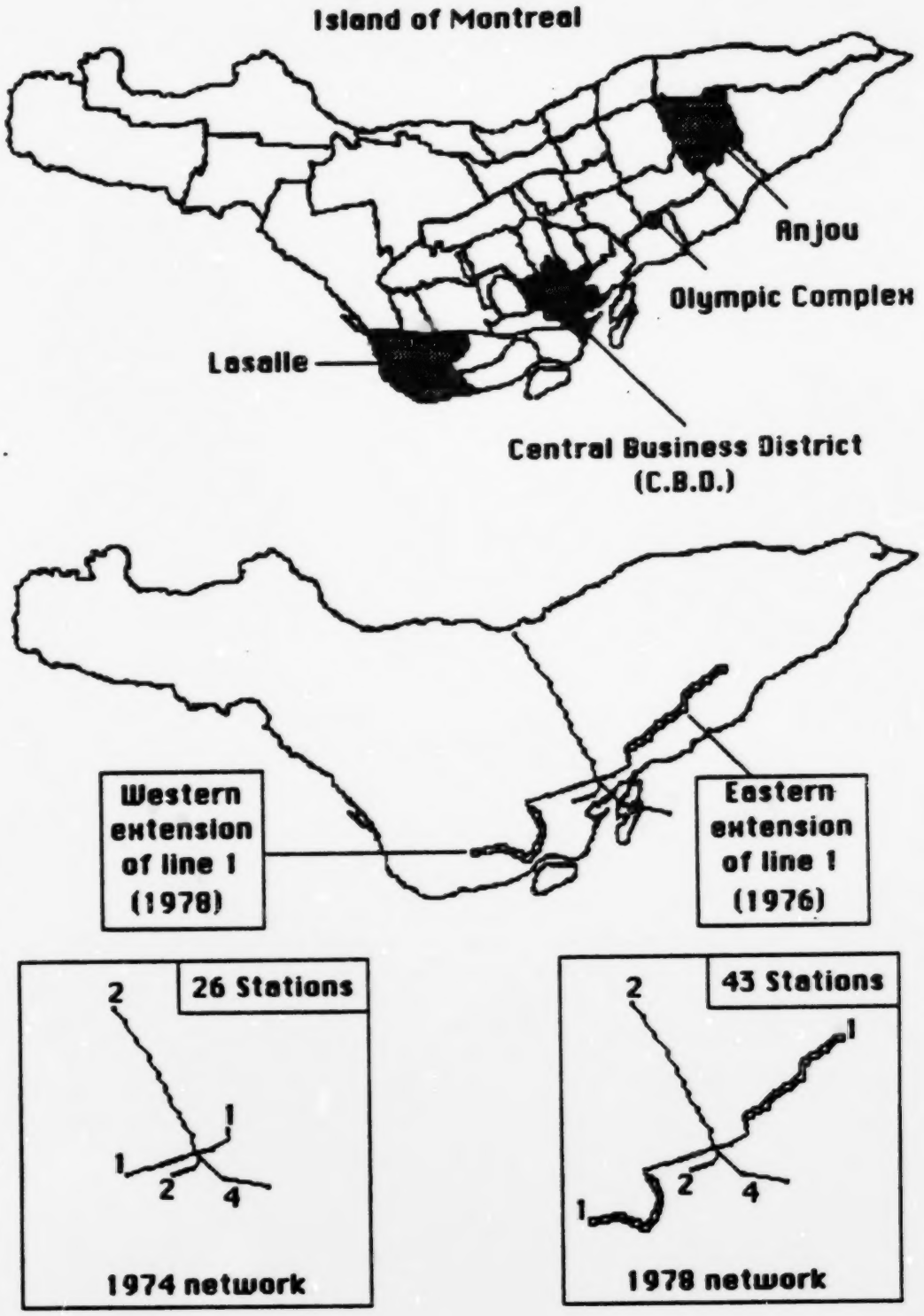


Figure 1. Montreal in 1974 and in 1978.

Considering all modes, on an average weekday, the Island of Montreal was the point of origin of 1 629 000 motorized trips and the point of destination of 1 777 000, these figures excluding the home-return trips. Public transport represented about 37% of these trips; 385 000 passengers used the transit network during the morning peak hours. Nearly 20% of all the trips (all modes) made during the morning peak hours have the CBD as their destination, where, due to the metro, the modal share for transit is an impressive 63%. In fact, public transit use in Montreal is among the highest in North America (see MUCTC 1984 (11)). Indeed, transit ridership in the largest US cities averages approximately 120 trips per year and per resident, compared to 180 in Montreal.

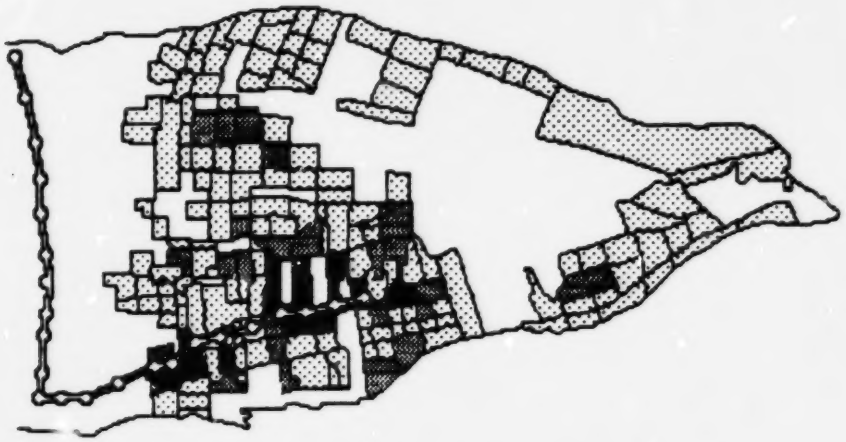
Due to its importance, the CBD is still the center of the subway system which has essentially a radial shape, unlike the surface transit network, which has a grid system configuration. Line 1 serves the East and the West of the Island, line 2 the Northern part and line 4 the site of 1967 World's Fair as well as the South shore.

IDENTIFICATION OF THE INFLUENCE ZONE OF THE EASTERN EXTENSION

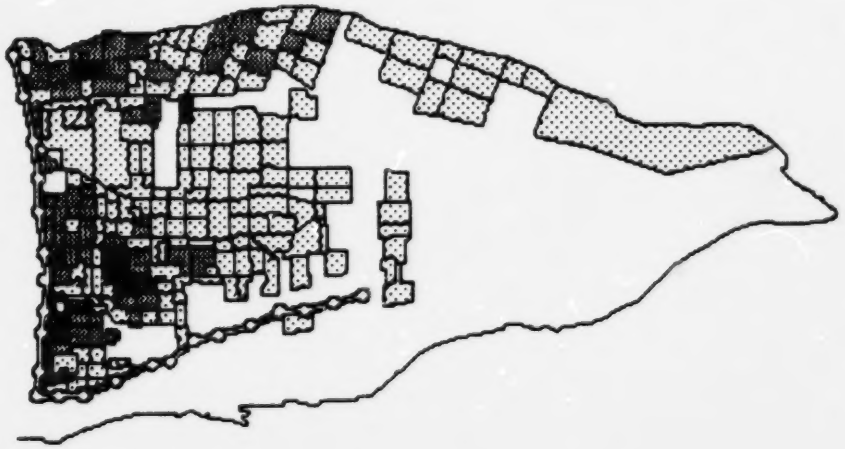
A study of the origins of the transit trips using the subway lines, all destinations considered in the O-D survey of 1978, gives a good characterization of the respective "drainage" (catchment) areas. Some zones are clearly attracted by the two lines, one of them being chosen by the transit rider according to travel time and location of the ultimate destination.

ANALYSIS OF DEMOGRAPHIC CHARACTERISTICS

Subways, as other urban infrastructures, are often considered by urban planners as having a strong impact on socio-economic



Area of attraction of subway line 1 (extension)



Area of attraction of subway line 2

Figure 2. Areas of attraction of subway lines 1 and 2.

factors. These effects are seemingly not measurable on a short period of time.

The evolution of the demographic profile of the Island of Montreal between 1970 and 1982 was marked by the following overall trends. Combined aging and urban sprawl have well known corrolaries: decrease of population and household size, increase of mobility and car ownership. At a more disaggregate zonal level, these phenomena may act quite differently. A key issue of the impact analysis is trying to clearly distinguish between the effects generated by the subway extension and the historical evolution had the subway not been built.

1. Population.

The population on the Island of Montreal has been continuously decreasing between 1970 and 1982, and furthermore, at an accelerating rate. Table 2 gives an indication of this trend.

Year	Population	Decrease of population	Car ownership (car/pers)	Household size	Density pers/km^2
1970	1 945 000		0.24	3.3	3995
		1.0 %			
1974	1 926 000		0.28	3.0	3955
		1.9 %			
1978	1 889 000		0.31	2.7	3880
		5.9 %			
1982	1 777 000		0.32	2.5	3650

Table 2. Evolution of the population on Montreal Island.

This trend, however, is not uniform over all sectors. Paradoxally, the most affected by the population decrease are those where the new metro extensions were built. It appears that, over the study period, the most densely populated sectors have gradually become less populated. This phenomenon goes together with an increase of population in the peripheral suburban sectors and tends to be the same all over the territory. This

trend parallels a population movement towards the suburbs outside the MUC; one can observe an increase in overall population in the Greater Montreal.

Even if the subway extensions have been built in the most densely populated sectors (CTCUM 1970 (12),1972 (13)), this new facility has not been enough to reverse this population trend.

2. Household Size.

Household size appears to be the most changing variable in "modern" times. A similar behavior is also observed here. The decrease mentioned in table 2 corresponds very closely to the trend in other North American cities (example Baltimore 1985 (14)). The number of persons per household increases nevertheless with the distance from the CBD as families with several children tend to live in the suburbs. This fact seems typical of the whole Island, but the decrease is slightly stronger in the zones adjacent to subway line 1. This phenomenon could be explained by the increase in the number of households with 1 or 2 persons because of massive access of young people to adulthood and property, a well recognized consequence of the after World War II "baby boom". These households might prefer to live near the subway in order to take advantage of the accessibility to the CBD. But with the available data, no significant change in the usual trend could be detected over a 6 years period.

3. Car Ownership.

During the last 15 years, car ownership has continuously increased, trend slowed down by the economic recession of 1981, as also illustrated in table 2. Like for the household size, a strong relationship exists between car ownership and distance from the CBD, but the observed increases within the zones adjacent to the new line are in all points similar to the average values of the MUC. This observation suggests that the extension did not have any discernable influence on car ownership.

4. Age distribution.

According to the figures reported by the O-D surveys, an overall aging of the population on the Island can be observed, the "oldest" sectors being those where the subway already existed in 1970. A similar development can be seen in the area touched by the new subway extension between 1974 and 1978. This continuous trend suggests that, on a short time period, the metro extension has had no influence on this population characteristic, which might depend on outside factors.

Thus, on the basis of this Montreal case, it may be concluded that if a subway has to have any structuring urbanistic effect on urban (and maybe underprivileged) sectors, it may take a period of at least 10 years to be measurable.

TRANSIT TRAVEL DEMAND

The number of trips made by public transport has increased at a rate of 11% per 4 years since 1974. This steady increase seems still more significant when considering the population decrease in the MUC meanwhile. According to an extensive study of the mobility behavior of the Montreal urban travelers (Chapleau 1986 (15)), both --average weekday per capita total and transit-- trip rates have progressed upward from 1974 to 1982: total trip rate moved from 1.79 to 2.05, while transit trip rate stepped from 0.52 to 0.66. The increase in transit usage is not distributed uniformly over space. This is illustrated by the figure 3.

It appears that the sectors located along the line 1 extensions experienced the highest increases; this is particularly so in the zones at the East and West end of line 1 where increases of 58 % (Anjou) and 43% (Lasalle) were registered. These high values might be explained by the fact that, in the 1974-78 period, new housing developments (slight increases of 14% and 19% in the number of households) took place which might have attracted

potential metro users not yet used to driving to work. It seemr difficult to induce drivers to use the metro and as one could observe, modal changes were often of temporary nature.

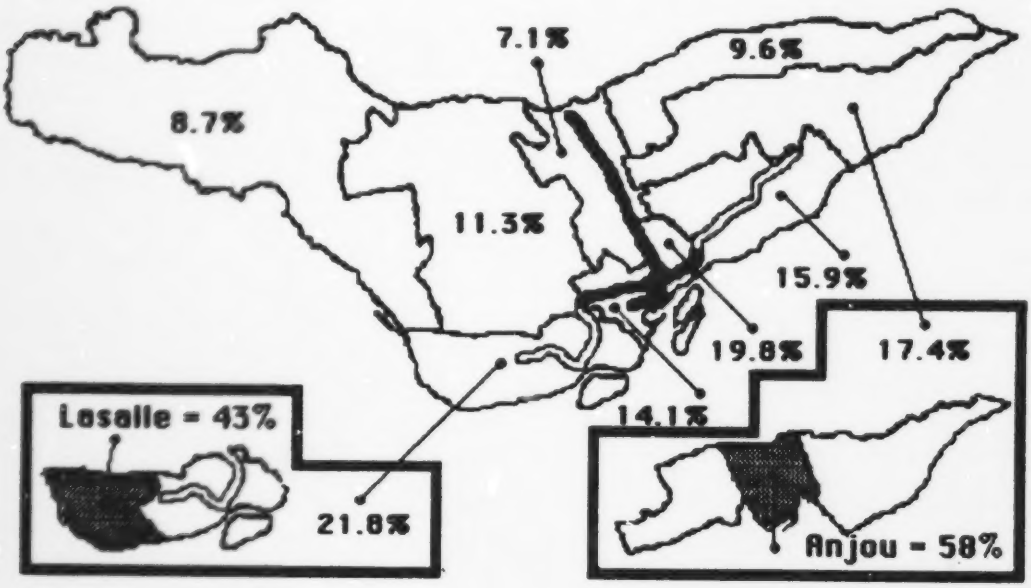


Figure 3. Rate of increase in the number of trips per person between 1974 and 1978

It can be concluded that the new subway extensions have had a positive effect on transit ridership. But it may also be conjectured from (15) that transit benefited primarily from demographics: progression of specific age-sex cohorts (15-24 year-old, senior citizen's groups) in the nearest suburbs.

MODAL SPLIT

1. Share of the Market.

Does a subway extension influence the modal share in the adjacent sectors? To what extent are car users attracted by the new line? The results of the study give a preliminary and partial answer to these questions.

With respect to the market share, one can observe a remarkably stable situation over the period covered by the last 4 O-D surveys. Transit share remained stable at the 37.0% mark + or - 0.2% of all motorized trips made in the MUC from 1970 to 1982. There are however significant differences between the sectors. Figure 4 and table 3 illustrate the spatial distribution of this market share.

The sectors were grouped according to the evolution of the market share over the last 8 years. The first group of sectors (A) represent those zones adjacent to the new subway lines. One can observe a slight increase of market share of 1 to 3% in these sectors (between 1974 and 1978), while there was a decrease of 1 to 4% in sectors 4,6,7 where there was no change to the public transport network. The grouping (C) experienced a slight decrease between 1974 and 1978 and a subsequent increase. The increase in sector 1 can be explained by a very significant expansion of the surface network to several suburban communities (served in 1974 and 1978 by private transit companies; values for this sector comprise MUCTC and other buses ridership (school buses, train, and private transit companies)). In the sector 9 finally, where the network was not changed and where no important housing development took place, the market share remained essentially stable.

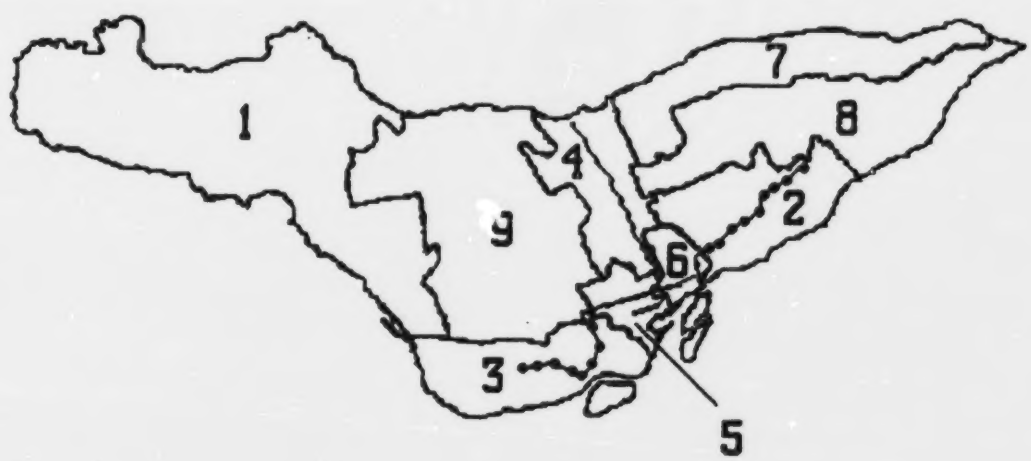


Figure 4. Proportion of trips made by public transport

Sector	Group	1974	1978	1982
2	A	43.0	43.9	42.2
3	A	39.0	41.9	40.5
8	A	34.7	35.5	34.5
4	B	50.6	47.7	46.4
6	B	52.3	52.0	48.5
7	B	38.7	38.2	37.0
1	C	28.9	23.0	27.2
5	C	47.8	45.0	46.9
9	D	37.1	37.2	37.2

Table 3. Proportion of trips made by public transport

Based on the figures established by the 1978 survey, one can conclude that the implementation of the metro line resulted in a temporary increase in the market share. However, in the second period, this gain was lost in part and the market share sank in many cases under the level of 1974. In fact, these data seem to prove that, as long as the network is stable, the market share tends to stabilize or decrease. The introduction of a new metro line improves temporarily the market share in the adjacent zones, but the initial downward trend is resumed after a fairly short period. It is particularly worthwhile to notice that the extension of line 1 (sectors 2 and 8) to the East showed a net loss of market share in 1982 of 0.8% to 0.2% below the level of 1974, thus before the opening of the new metro stations.

The municipalities of Anjou and Lasalle were the most successful sectors with respect to the change in market share. Table 4 shows the evolution in these municipalities but there is, nevertheless, an overall trend of decreasing shares between 1978 and 1982.

The new survey of 1987 will permit interesting conclusions to be drawn with respect to this temporal evolution.

Sector	1974	1978	1982
Anjou	25.8	32.4	31.9
Lasalle	29.5	37.7	36.4

Table 4. Development of market share in two municipalities of the MUC.

Thus, the construction of the new metro line extension has contributed to an increase in market share but this gain had been lost nearly everywhere 4 years later. Note that transit ridership increased in the 1978-1982 period, due to the increased mobility of the population; so, in spite of a relative loss, there is still an absolute gain. The fact is that private cars constitute the driving force of the global mobility increase.

2. The radius of influence of the metro line extensions.

It is interesting to measure the distance over which the modal split was increased after the opening of the new line. This effect is looked at by studying the most disaggregated survey data on a zonal level (1135 zones, average area 0.42 km2). For that purpose, zones were grouped with respect to the distance of their centroid from the nearest metro station. Table 5 shows the modal split in 1974 and 1978 for the six groups studied.

A net gain of approximately 5% was observed over a distance of 1.25 km (0.75 miles) followed by a steep decay, so that after 1.67 km (1 mile) the positive influence of the subway disappears. The zone of influence with respect to modal split seems thus limited to a band of approximately 1 mile on both sides of the metro extension.

Grouping	Distance Km	(Miles)	Modal Split % 1974	1978	Difference %
A	0.00 - 0.42	(0.00 - 0.25)	39.9	44.7	4.8
B	0.42 - 0.83	(0.25 - 0.50)	37.7	43.6	5.9
C	0.83 - 1.25	(0.50 - 0.75)	38.4	43.5	5.1
D	1.25 - 1.67	(0.75 - 1.00)	41.2	42.9	1.7
E	1.67 - 2.08	(1.00 - 1.25)	38.9	37.9	-1.0
F	2.08 - 2.50	(1.25 - 1.50)	42.7	40.0	-2.7

Table 5. Change of modal split with respect to distance from the metro line

TRAVEL DEMAND CHARACTERISTICS

The main contribution of subway implementation is speed substitution; typically, in Montreal, the commercial speed of the metro is about 35-40 km/hr as opposed to an average of 15-20 km/hr for bus. Low headway and regularity contribute also to the reduction of travel time of subway users, often at the expense of an increase in the number of transfers. For a detailed analysis of travel demand, every transit trip observed in the O-D surveys of 1974 and 1978 is studied and travel attributes are estimated with the previously mentioned MADITUC simulation model. Figures 5 and 6 illustrate the spatial distribution of the difference of average travel times --strictly speaking, impedance function composed of access (walk), waiting, in-vehicle times with appropriate weighting factors in addition to tranfer and modal penalties-- and of the difference of average number of transit lines taken by transit riders in 1974 and 1978.

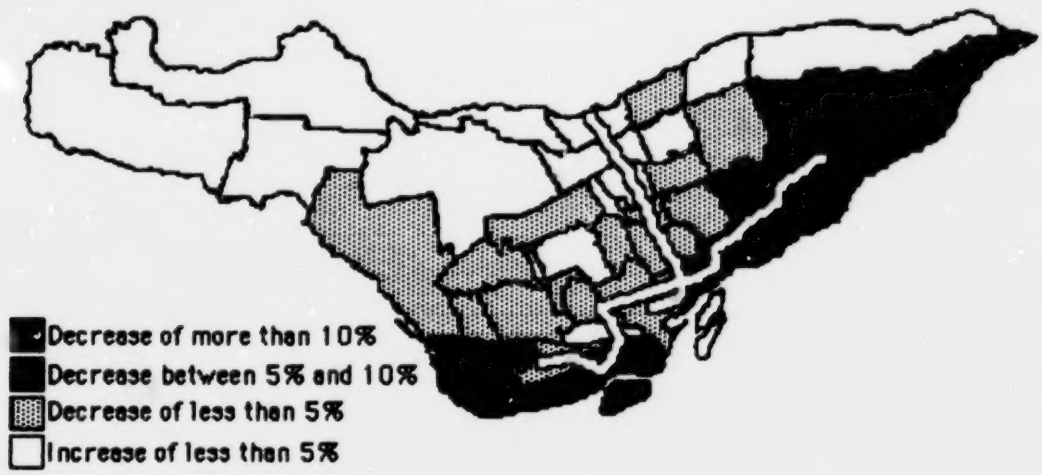


Figure 5. Evolution of average trip time between 1974 and 1978.

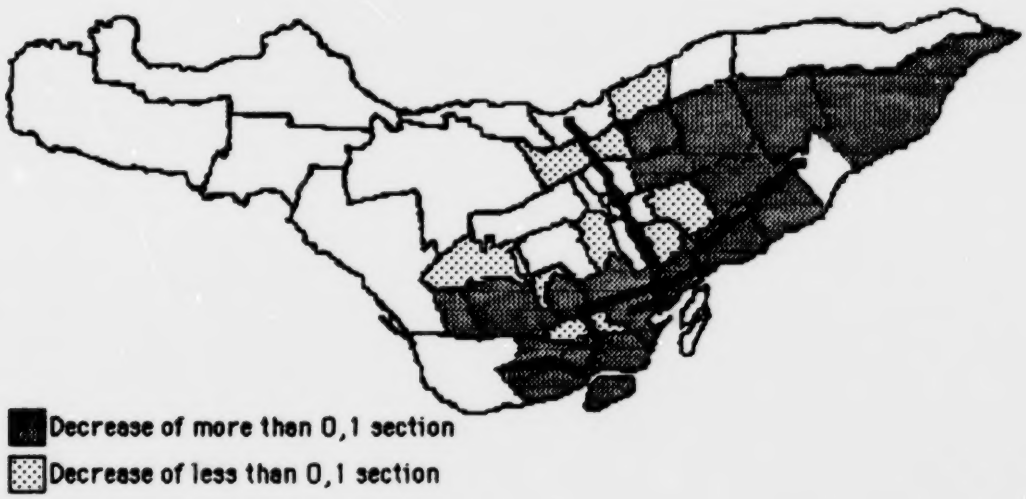


Figure 6. Evolution of number of lines used for a trip between 1974 and 1978.

Normally, a subway implementation has a detrimental effect on the number of transfers users experiment. Here, because of the very nature of the line extension, we have observed the opposite. It appears clearly that the users from the sectors adjacent to the metro extension (number 1 at its East and West end)

needed less transfers and got to their destinations faster in 1978 than in 1974 and this, in spite of longer trips. In summary, large areas have benefited from the service improvement and the consequent user cost reduction.

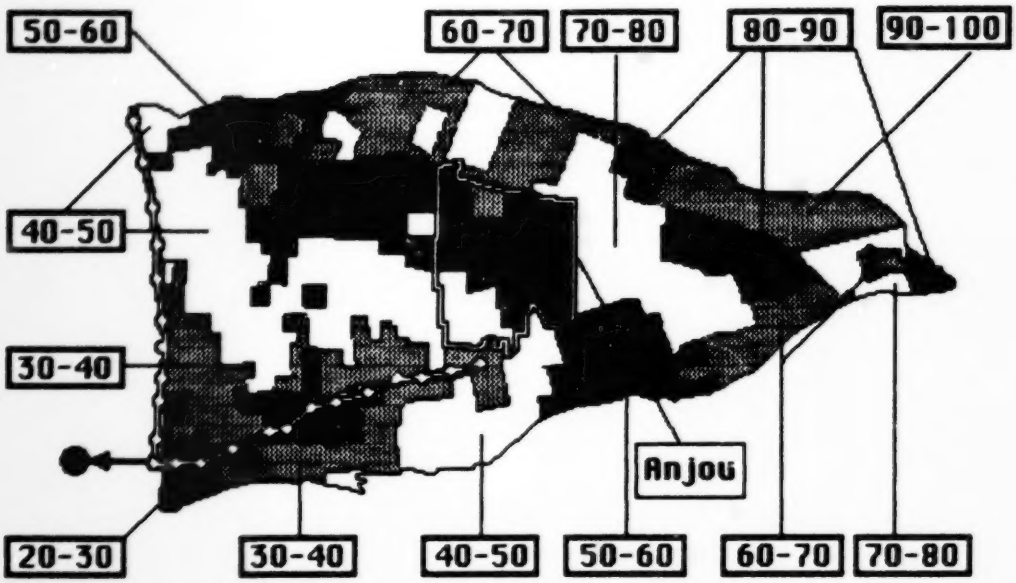
ACCESSIBILITY TO CBD

As a system, the main role of the Montreal metro is to facilitate accessibility to the CBD. Statistics show that, for the CBD as a destination, in the a.m. peak period, the share of transit is of the order of 57%, mainly due to the existence of the subway system. The extensions confirm this role, and insofar, have contributed a net increase of 5%. It may be recalled that the CBD sector is served by the two main metro lines; line 1, which brings people from East and West, and line 2 coming from the North.

Shortest paths, with the same previously calibrated impedance function, were computed with the respective attributes of the 1974 and 1978 networks (line lengths, commercial speeds, headways). Results illustrated on figures 7 and 8 represent calculations done in regard to a CBD destination near each metro line, this last precaution being taken because of the importance of transfers.

Good coherence is noted between areas of larger gains in travel time and zone of influence of the subway extension already shown in figure 2. Remarkably, the sector with the largest time savings is precisely Anjou, where MUCTC recorded his best modal split results.

Considering both destinations, these maximum savings were estimated to 25-30 minutes (in generalized time units). In the second case, the area experiencing this maximum gain is much larger, comprising almost the whole Anjou municipality.



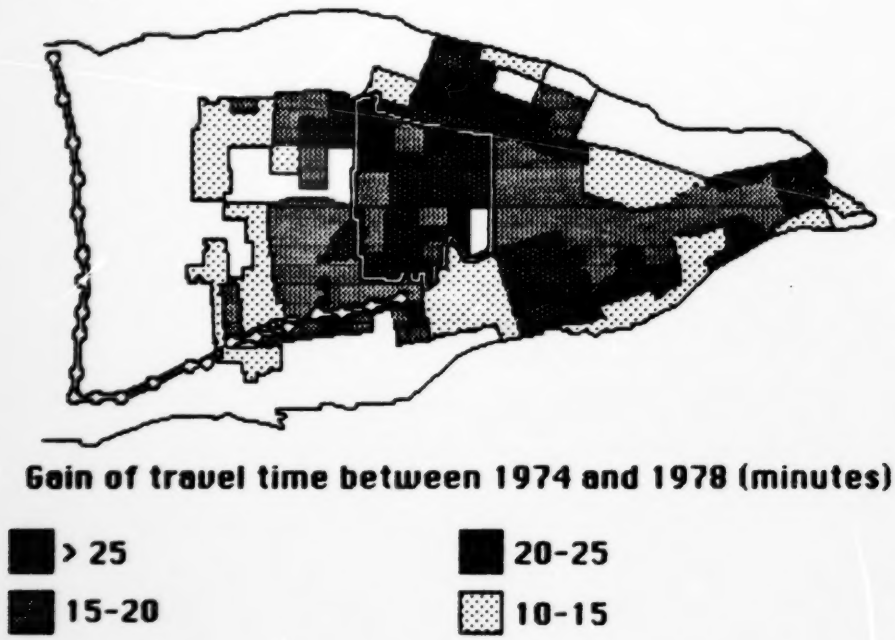
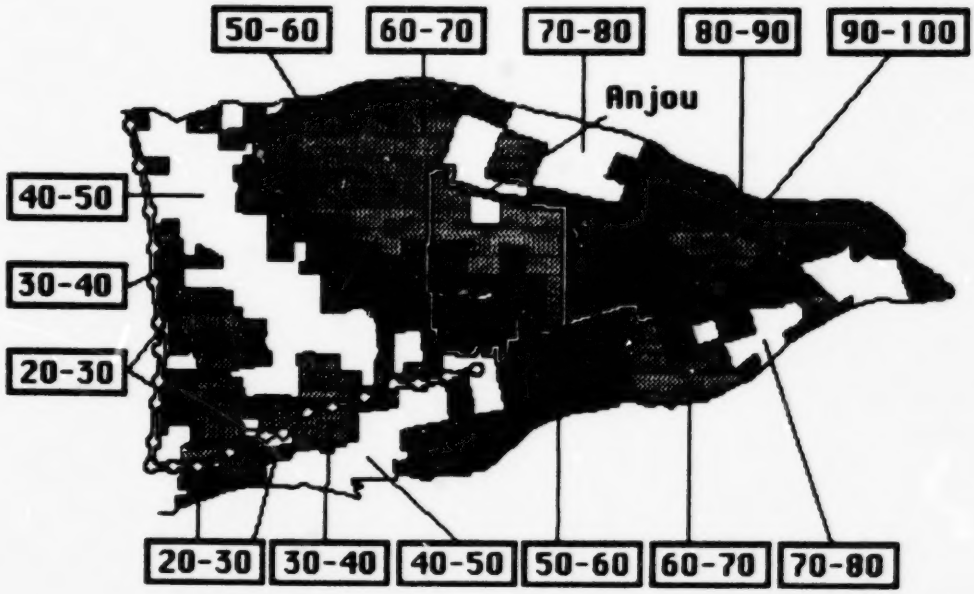


Figure 7. Access to CBD near line 1



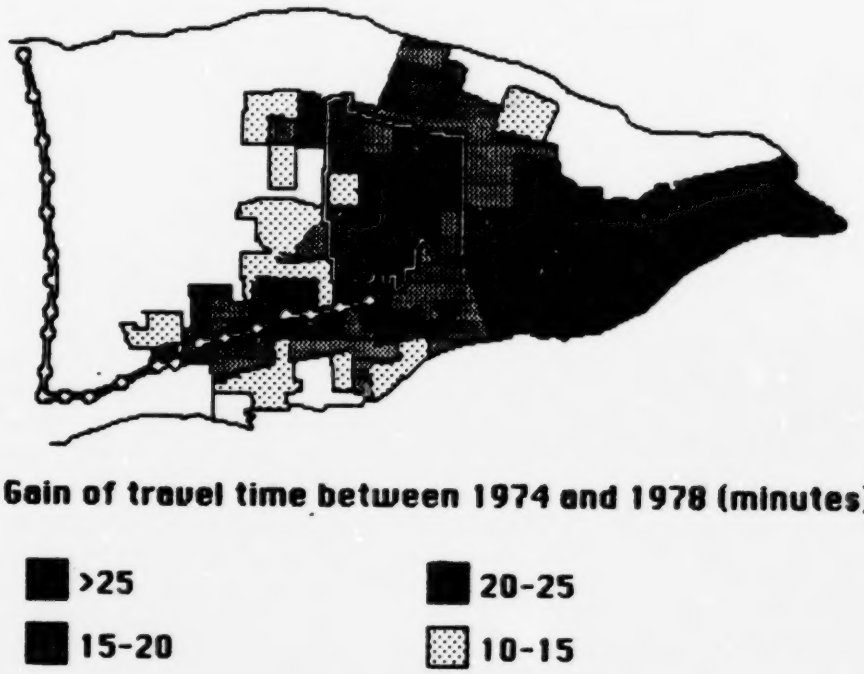


Figure 8. Access to CBD near line 2

In order to identify the strengths and weaknesses of a metro extension scenario, this kind of analysis offers the interesting possibility to measure the spatial distribution of the time benefits. In our case, an a posteriori impact study allowed us to understand part of the fact why residents of Anjou significantly increased their mobility in public transit.

TRAVEL BENEFITS' ESTIMATION

The present analysis is carried out on the whole network, in part to simplify the analysis and also because most trips are made on the sub-network adjacent to the metro extension as well as on the remaining network. Travel time savings were obtained by loading the 1978 a.m. peak demand on the 1974 and 1978 transit networks, applying a calibrated "all or nothing" assignment model (MADITUC, Chapleau (1982)). Simulation indicated an overall reduction of 11500 hours of generalized travel time during the weekday a.m. peak period, consisting mainly of significant time differences: for instance, for all trips originating from the Anjou sector, the average time saving is 9.75 minutes per transit trip. In the neighbourhood of the Eastern subway extension, one observes close to 50% of these savings experienced by about less than 20% of the total demand.

Estimates of the operational resources --vehicle-hours-- computed with the network data used in the trip assignment model give the followings for the surface network touched by the Eastern extension: decrease of 270 veh-hrs for parallel bus routes, increase of 180 veh-hrs for perpendicular ones (feeding line 1) and an increase of 70 veh-hrs for other services in the East. The net gain is very slim compared to the added costs of supplying resources for the corresponding lengthening of subway line 1 (mostly tripling the metro vehicle-hours because of the simultaneous East and West extensions).

Factors exterior to the analysis are worth mentioning. The

extension of a subway line has, in any case, a detrimental effect on the utilization ratio (pass-km/seats-km), if no short line is introduced. All things being equal, the maximum load point volume increases, necessiting more vehicles, these vehicles having to travel a longer distance to complete their circuit. At this point, for the a.m. peak period in 1978 compared to 1974, maximum link volume on metro line 2 dropped 4500 from 52500, while maximum link volume on metro line 1 increased 11000 from 33000. Finally, one can observe that the economy, on the surface network, of buses is counteracted by another phenomenon: because of the better regularity of the metro service, transit riders have a tendency to reduce the spread of the peak period, accentuating the requirements of feeder bus fleet, and then, increasing the involved resources.

CONCLUSION

The O-D surveys carried out by the MUCTC at frequent intervals allowed us to analyze on an after/before scheme the impacts of some transportation investments. Another survey is planned for the end of 1987; from this new data, 10 years later, it is hoped to evaluate more medium-term impacts.

From a planning point of view, we found that precise historical data on the supply side were not truly available or recoverable. At the moment of planning of these projects, more attention was given to the "technology aspect" (capacity analysis problem) instead of cost or productivity dimensions. This explains why analysis was not capable of discriminating factors related to scale economies on resources usually obtained with rail transit investment projects.

Nevertheless, the multidimensional analysis done so far allows us to retain some elements of conclusion. It is as follows:

-------> Contrary to the beliefs of numerous urban planners,

based on the Montreal case, subway extensions do not have any significant structuring effect on a short term horizon: no different trends in demographics have been noted in the neighbourhood of the new metro stations.

-------> The overall transit ridership has been positively maintained with the subway extension, due essentially to the general increase of mobility.

-------> With respect to modal split, the opening of the extension had a stepping up effect. Nevertheless, this gain is decayed over time. In fact the positive effect was kept over only two municipalities (Anjou and Lasalle) for a period of 6 years. The modal split has decreased in favor of the car in all other sectors and this, to or below the level observed before the opening of the extension.

-------> Subway seems to have, on a short time horizon, a very localized impact on transit usage. The increase in market share for the public transit is diminishing rapidly with distance from the subway stations. In fact, there was no gain outside a one-mile band on both sides of the subway line.

-------> Transit users experience significant gains in travel times and need to do less transfers to make a trip during peak hours. This last result is fortuitous for a subway implementation; here, it depends on the nature itself of the extension: all those having direct access to the new line 1 save a transfer if going into the CBD.

Other aspects have also been investigated, but may not be validated because of the "weak" quality of operational data available for network situations existing more than 12 years ago. Since then, planners have learned to invest also in data characterizing the supply side of urban transport.

Finally, the main result emerging from the Montreal case is

that planners must refrain themselves from dreaming too much on apprehended short-term benefits caused by a transit infrastructure. Real benefits seem to come from, and would be more easily explainable, the dynamics of the urban demography. It is a conjecture to be validated in future research.

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